National Aeronautics and Space Administration

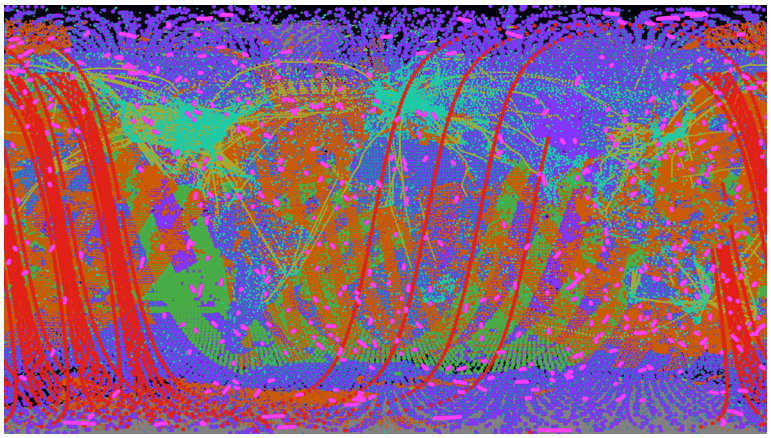
NASA Center for Climate Simulation & Global Modeling and Assimilation Office Success Story

New Animation Shows Millions of Earth Observations for Forecasting

July 28, 2015

Above Earth's continents and oceans colored dots burst like fireworks, fly in rectangular formations, and spin fine webs. Eventually a multitude of dots overlay the world as if painting a surreal picture. This animation is not merely artwork—each dot represents an observation from a satellite or other source. More than 5 million observations accumulate every 6 hours to drive weather forecasts by NASA's Global Modeling and Assimilation Office (GMAO).

These forecasts run at the NASA Center for Climate Simulation (NCCS) using GMAO's GEOS-5 Data Assimilation System (DAS). "Data assimilation is a process of blending observational and model information to produce the most accurate and physically consistent picture of the atmosphere at a given time," said Ron Gelaro, GMAO lead scientist for atmospheric data assimilation. GEOS-5 DAS couples an atmospheric model to an analysis routine that ingests the observations weighted by their accuracy. The goal is to provide the best possible starting point for the forecasts, which support NASA satellite instrument teams, field campaigns, and weather and climate research.



As shown in this enhanced animation snapshot, NASA's Global Modeling and Assimilation Office uses observations from many sources to drive weather forecasts supporting agency research efforts. Image by Will McCarty, NASA GSFC.

Observations stream into GEOS-5 DAS from many different sources provided by NASA and national and international partners. "We take all the high-quality data we can get our hands on in a timely enough fashion," said Will McCarty, the GMAO research meteorologist who created the animation. "For the model you need to know what the world is for every point for every variable."

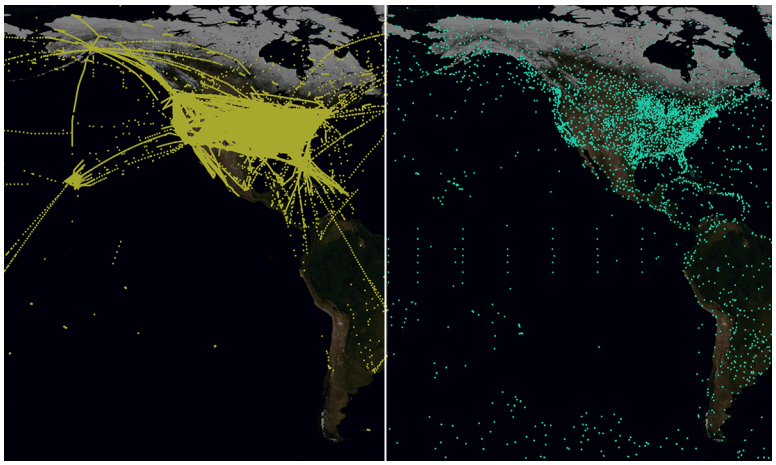
The essential forecast variables are temperature, water, wind, surface pressure, and ozone. Whether measuring these values directly or deriving them in other ways, the assimilated observations come in eight major types (colors are from the animation):

Observation Type	Variables Measured	Example Sources
Conventional Observations (Surface)	Temperature, water, wind, and surface pressure – all directly measured	Land surface stations, ocean buoys
Conventional Observations (Upper Air)		Weather balloons, commercial aircraft
Satellite-Derived Winds	Winds derived from cloud motion or ocean roughness	RapidScat – International Space Station (new)
Microwave Imager Radiances	Water vapor, clouds, and precipitation derived from microwave radiation	Global Precipitation Measurement (GPM) Microwave Imager – GPM satellite (new)
Infrared Radiances (60% of observations assimilated)	Temperature and water vapor derived from infrared radiation	Atmospheric Infrared Sounder – Aqua satellite; Infrared Atmospheric Sounding Interferometer – EUMETSAT satellites
Microwave Sounder Radiances	Vertical temperature and water vapor derived from microwave radiation	Advanced Technology Microwave Sounder – Suomi NPP satellite
GPS Radio Occultation	Vertical temperature derived from GPS beams	COSMIC satellite constellation
Satellite-Derived Ozone	Ozone derived from microwave, visible, and ultraviolet radiation	Microwave Limb Sounder, Ozone Monitoring Instrument – Aura satellite

Even 5 million observations do not cover 100% of the planet, so the model must fill in the gaps. “Blending observations with the model uses the strengths of each and produces something better than either source alone,” Gelaro said.

Running this process continuously requires 700 to 1,000 processor-cores on the NCCS Discover supercomputer. GMAO’s plan to double GEOS-5 model resolution from 25 to 12.5 kilometers by year’s end will demand 10 times the processing power. Gelaro said it is challenging to write model code that can take advantage of so many cores. “We are lucky to have NCCS as a partner,” he said. “Not only do they provide these resources, but we also find out about the strengths and weaknesses of our code and they find out what works well on their supercomputer.”

GEOS-5 DAS forecast data (hosted by the NCCS Data Portal and NASA Distributed Active Archive Centers) and animated maps are accessible through the GMAO website. See More Information below.



Upper air (left) and surface (right) observations for the Western Hemisphere. Note the presence of flight tracks aloft over the United States and buoy observations in the central and southern Pacific Ocean. Image by Will McCarty, NASA GSFC.

Jarrett Cohen, NASA Goddard Space Flight Center

Contacts

Will McCarty
Research Meteorologist
Global Modeling and Assimilation Office
NASA Goddard Space Flight Center
will.mccarty@nasa.gov
301.614.6496

Ron Gelaro
Lead Scientist for Atmospheric Data Assimilation
Global Modeling and Assimilation Office
NASA Goddard Space Flight Center
ronald.gelaro-1@nasa.gov
301.614.6179

Dan Duffy
High-Performance Computing Lead
NASA Center for Climate Simulation
NASA Goddard Space Flight Center
daniel.q.duffy@nasa.gov
301.286.8830

More Information

From Observations to Models
http://svs.gsfc.nasa.gov/goto?30590

Global Modeling and Assimilation Office
http://gmao.gsfc.nasa.gov/

NASA Center for Climate Simulation
High-Performance Science
http://www.nccs.nasa.gov